Before the

FEDERAL COMMUNICATIONS COMMISSION
Washington, DC. 20554

In the Matter of	)	
	)	
Facilitating Opportunities for	)	**ET Docket No. 03-108**
Flexible, Efficient, and Reliable	)	
Spectrum Use Employing	)	
Cognitive Radio Technologies	)	
	)	
Authorization and Use of Software	)	**ET Docket No. 00-47**
Defined Radios	)	**(Terminated)**

To: The Commission

COMMENTS of Nickolaus E. Leggett
N3NL Amateur Radio Operator

The following is a set of comments from Nickolaus E. Leggett, an amateur radio operator (Extra Class licensee – call sign N3NL), inventor (U.S. Patents # 3,280,929 and 3,280,930 and one electronics invention patent application pending), and a certified electronics technician. I also have a Master of Arts degree in Political Science from the Johns Hopkins University (May 1970).

My comments discuss the consequences and aspects of using cognitive radio (CR) technology with a focus on radio astronomy, amateur radio, and national security aspects.

Radio Astronomy Aspects

The primary focus of cognitive radio technology is to increase the usage of the spectrum. In the NPRM, the Commission states that the Defense Advanced Research Projects Agency (DARPA) has a communications research program using CR

technology to increase spectrum usage by a factor of ten (Paragraph 16 of the NPRM). Such an increase in the efficiency of spectrum usage would have a negative impact on radio astronomy observations.

Currently radio astronomers conduct observations outside of the limited frequency bands allocated to radio astronomy, in addition to their observations within their allocated frequency bands. These "out-of-band" observations are carried out to observe the numerous celestial sources that are broad band in nature. The out-of-band observations are possible because much of the radio spectrum is lightly used, and so the radio observatories can observe these broadband objects despite the human interference. Both professional and amateur radio astronomers conduct these observations.

If CR technology succeeds in greatly increasing the density of spectrum usage, these out-of-band radio astronomy observations would be much more difficult than they are today. In the worst case, radio astronomy would be restricted to the frequencies specifically allocated to radio astronomy. This would inhibit the study of broad band radio sources as well as other scientific projects such as the search for extra terrestrial intelligence (SETI).

Since radio astronomy observatories are receive-only facilities, the CR devices could not detect them by radio emissions. Therefore, the CR devices would need a location sensing technology like that described in Paragraph 28 of the NPRM, to avoid interference to radio astronomy observatories listed in a database. This database should list both professional and amateur radio observatories. Alternatively, certain additional frequency bands could be mandated to be off limits for CR operation within the United

States to protect radio astronomy. In these newly defined frequency bands, the traditional communications technologies would continue to be used as they are now.

Amateur Radio Aspects

The Commission states that they wish to protect the ability of the amateur radio service to design, build, modify, and experiment with state-of-the-art radios including CR technology:

"Equipment used by amateur radio operators is generally exempt from a certification requirement. We have maintained this policy to encourage innovation and experimentation in the Amateur Radio Service. However, we are concerned that it may be possible for parties to modify SDRs marketed as amateur equipment to operate in frequencies bands not allocated to the Amateur Radio Service if appropriate security measures are not employed. However, we do not wish to prevent licensed amateurs from building or modifying equipment, including SDRs that operate only in amateur bands in accordance with the rules. Accordingly, we propose that manufactured SDRs that are designed to operate solely in amateur bands are exempt from the mandatory declaration and certification requirements, provided the equipment incorporates features in hardware to prevent operation outside of amateur bands. We seek comment on this proposal." [Paragraph 90 of the NPRM]

This position is very much appreciated by amateur radio inventors and experimenters such as myself.

Manufactured amateur radio CR equipment could be equipped with bandpass filters to restrict the transmitter's output to the allocated amateur radio bands. This would allow the amateur radio operators to develop new CR software while constraining the emissions to the amateur radio bands.

Similarly, amateurs building their own CR transmitters will use filtering of the output signal to prevent interference to other radio services. This is an accepted responsibility and tradition within the amateur radio service.

In the following two paragraphs of the NPRM (Paragraphs 91 and 92), the Commission expresses concern about the possible future use of high-speed personal computers and advanced digital-to-analog converters (DACs) to make unregulated radio

transmitters. In my opinion, such an advanced computer and DAC combination would be an ideal method for making a software-defined cognitive radio.

It is likely that the amateur radio community could initially live with the proposed restriction on such computer/transmitter combinations (Paragraph 92):

"Would it make sense to require that digital-to-analog converters marketed as computer peripherals that 1) operate at more than one million digital input samples/second, 2) have output power levels greater than 100 mW and, 3) have an output connector for the analog output be limited in marketing to commercial, industrial and business users as we require for Class A digital devices?"

Operating the DAC at an output power of less than 100 mW would be acceptable for amateur radio QRP communication. For higher power amateur radio communication, the output of the DAC would be fed through a bandpass filter to a linear amplifier. The output of this amplifier would be fed through another filter or matching transformer to the antenna. This way the computer and DAC would operate as a driver for a conventional amateur radio amplifier.

However, such a combination of old and new technology would be rather like the ships that had both sails and steam engines. It is a transitional technology that will eventually be replaced by the new technology.

Eventually DACs could be marketed for the amateur radio service (and for other radio services) equipped with appropriate hardware filters to constrain the emissions to the authorized frequency bands. High power DACs would allow the computer to operate directly as a fully digital transmitter or transceiver for amateur radio communications of various modes (visual, audio, digital data, keyboard, Morse Code, and radio control signals). Clearly the trend in radio technology is going in this direction.

I am skeptical of the proposal to operate Part 15 devices at higher powers in rural areas (Paragraph 38):

"We propose to allow a transmitter power increase of up to 6 times (approximately 8 dB) higher than the current limits in the 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz bands under Section 15.247 of the rules, and in the 902-928 MHz, 2400-2483.5 MHz, 5725-5875 MHz and 24.0-24.25 GHz bands under Section 15.249 of the rules."

This increase in power would cause increased interference to amateur radio operation which is primarily weak signal communication including unusual over-the-horizon propagation modes. Again we see an example of the Commission accepting a noisier spectrum instead of insisting on strong protection of the integrity of the spectrum.

Manual and Automatic Radio Operation

Manually operated radios and cognitive radio operation would not mix well from an operational standpoint. This is due to the different speeds at which the human operator and the CR system operate. A human radio operator would not have the time to detect an empty channel or frequency and place a call before a CR system detects and fills the empty frequency with its operation. The human operator would see a spectrum full of continuously busy CR traffic where he or she would not have the time to transmit a call.

National Security Considerations

The widespread use of CR technology has national security implications. A high dependency on wireless technology increases the vulnerability of the communications infrastructure to intentional damage by terrorists and/or rogue nations.

These hostile parties could damage the wireless infrastructure by high power microwave (HPM) or Electromagnetic Pulse (EMP) attacks. These attacks would

disable the sensitive microprocessor and radio frequency components of the CR devices and networks.

In the past, the Commission has been reluctant to take positive action on this issue. In petitions RM-5528 and RM-10330 filed by Donald J. Schellhardt and myself, the Commission declined the opportunity to issue a Notice of Inquiry or a Notice of Proposed Rulemaking on this subject.

However, with the Commission strongly encouraging the development of highly vulnerable wireless technology, the Commission should examine this subject again and develop reasonable steps for protecting both wired and wireless networks from electromagnetic attack. In addition, the Commission should be encouraging the use of fiber optics to the desktop as a constructive response to the vulnerability issue.

Suggested Actions

The Commission should take the steps suggested to protect radio astronomy operations from CR interference. Also, the Commission should protect the amateur radio service from non-amateur CR interference. In addition, amateur radio operators should be encouraged to experiment with the CR technology. This should include the use of PCs with advanced RF DACs as amateur radio transmitters and transceivers.

The vulnerability of CR technology to electromagnetic attack should be evaluated in a separate Notice of Inquiry.

Respectfully submitted,

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